SIM Metrology

S. Shaklan and A. Kuhnert

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Presentation to SIM-SWG

What's new

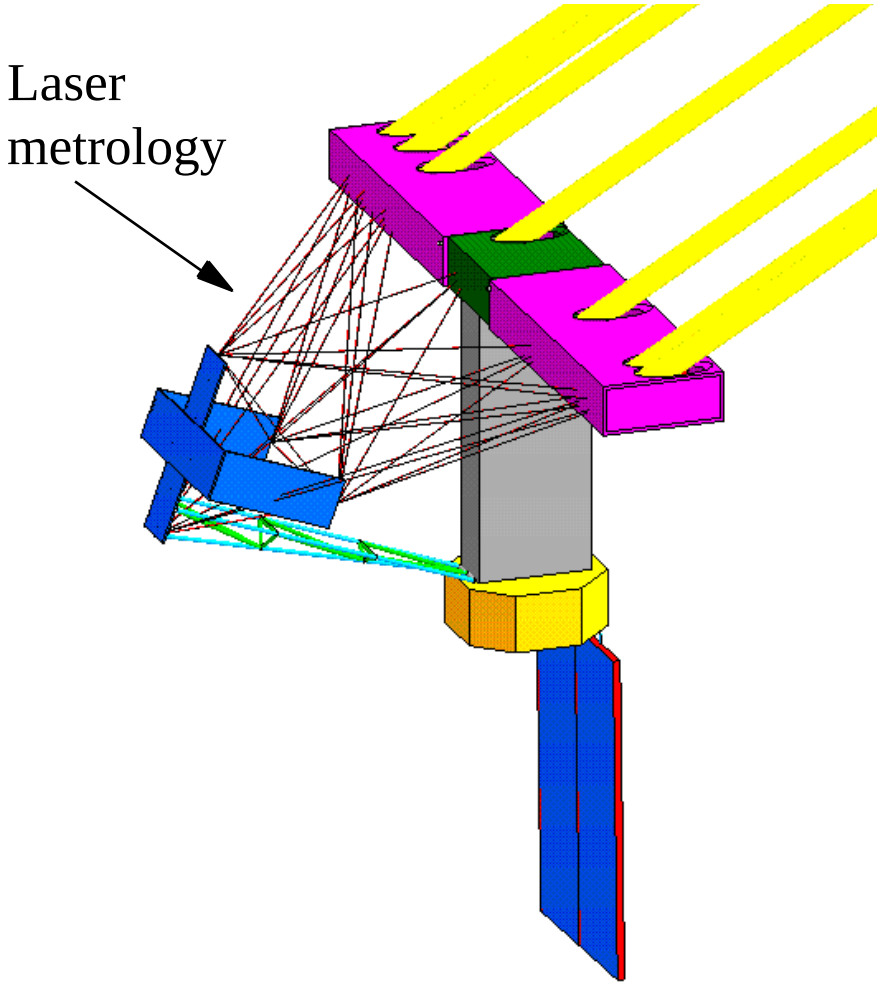
- External metrology truss is gone.
- Laser source measures relative not absolute distance.
- We have built a triple corner cube (and 3 more are on the way).
- Some operational considerations
  - short baseline, beam expansion, thermal control, pointing dither

The Metrology System

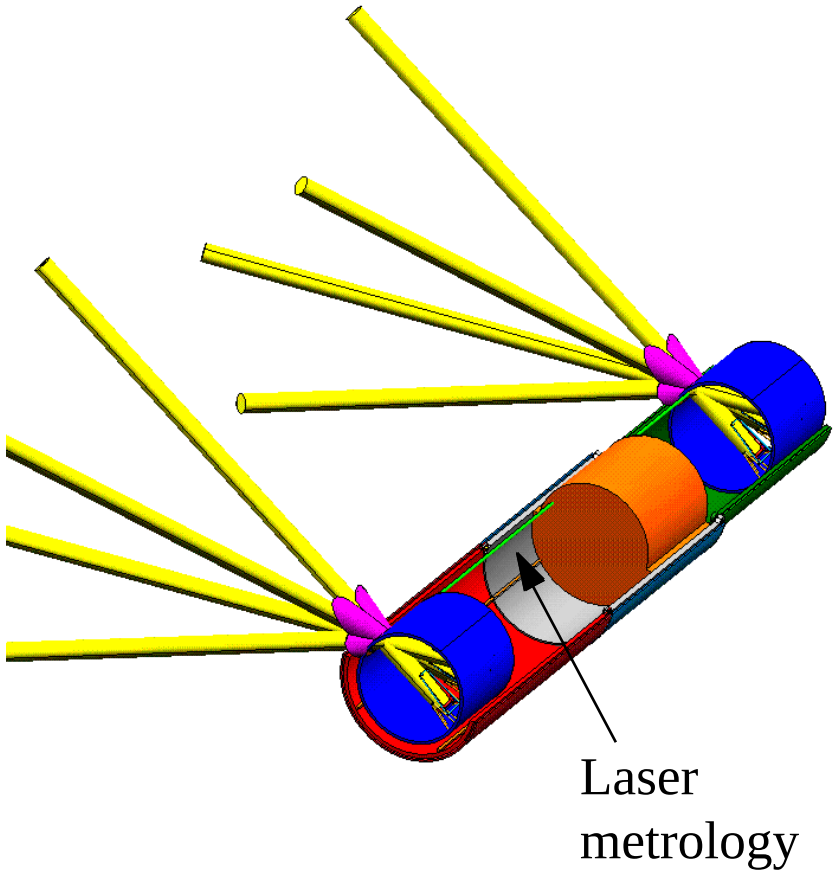
SIM's Ultra-High Precision Meter Stick

- Laser source
- Beam Launchers
- Fiducials
- Detectors
- Phase meters
- Computer Processing

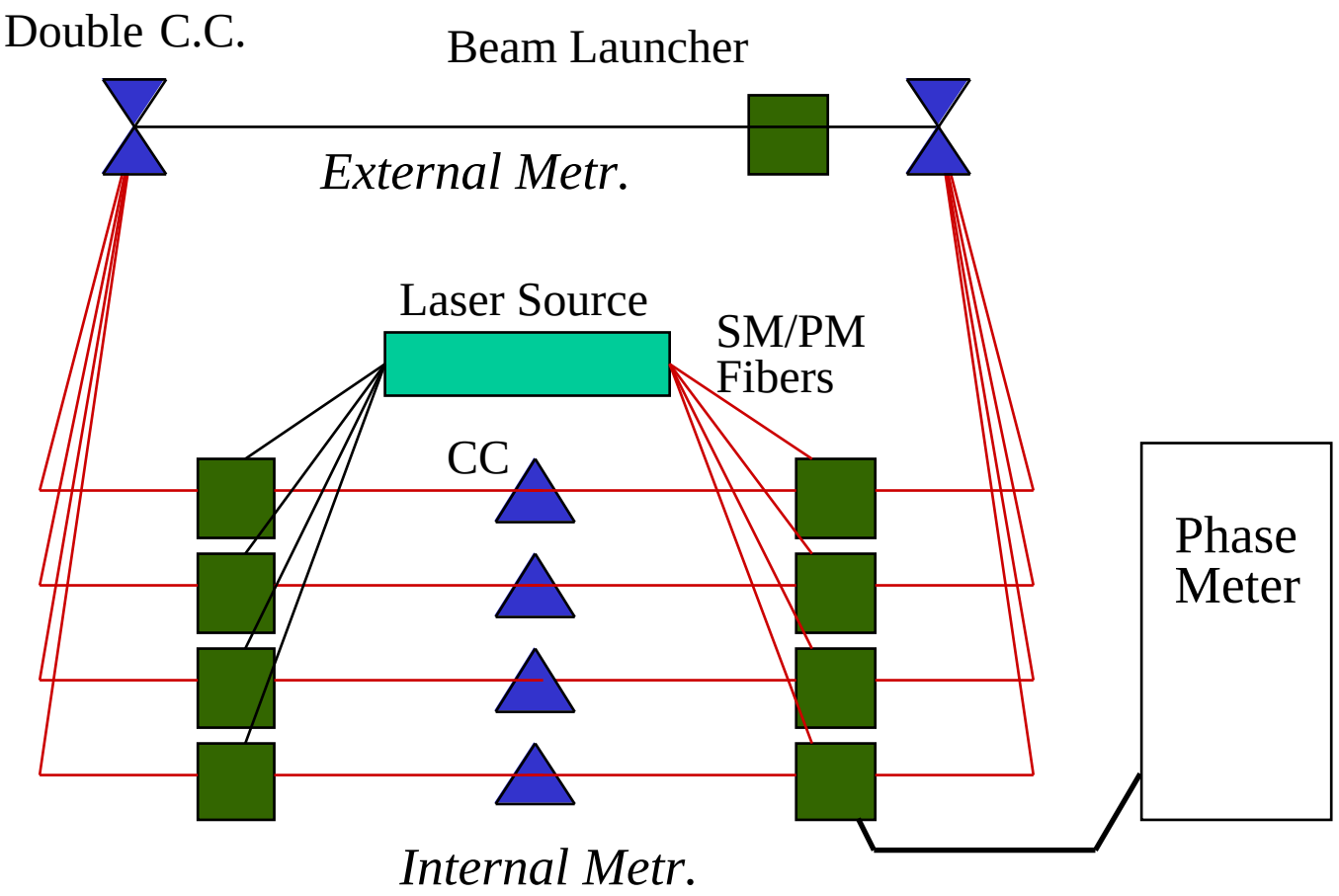
SIM Classic



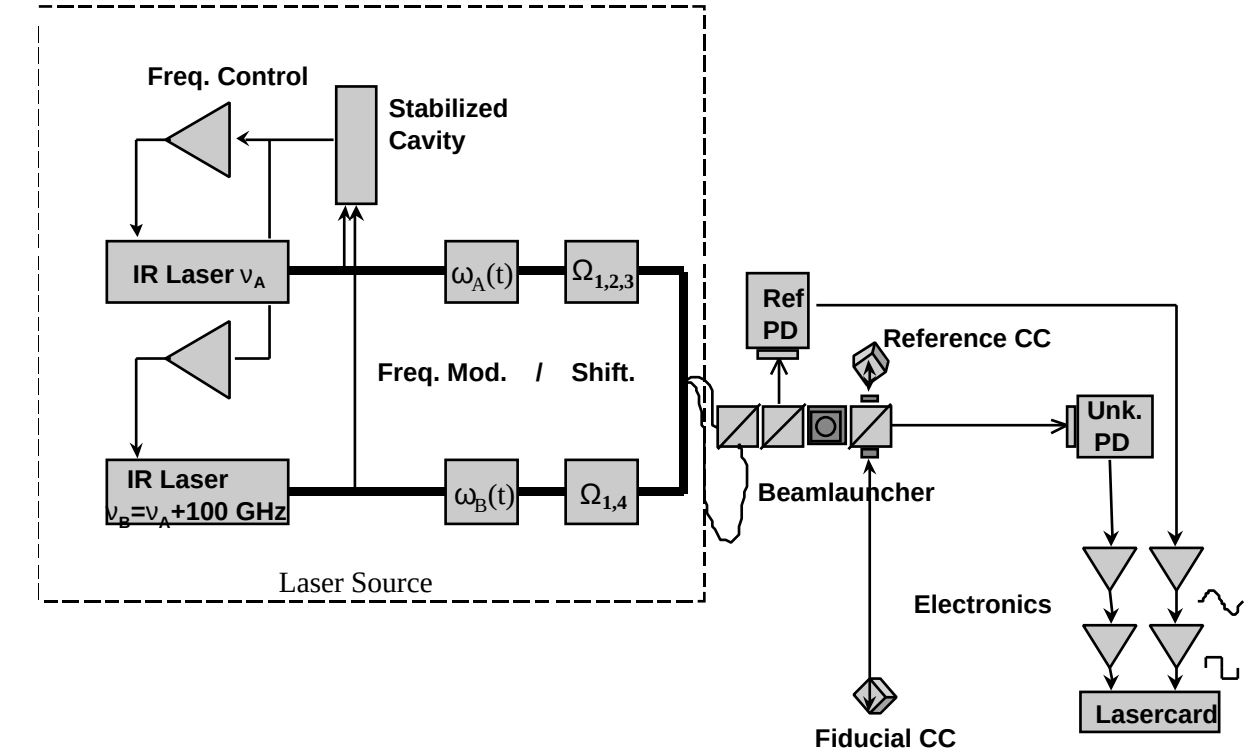
SOS



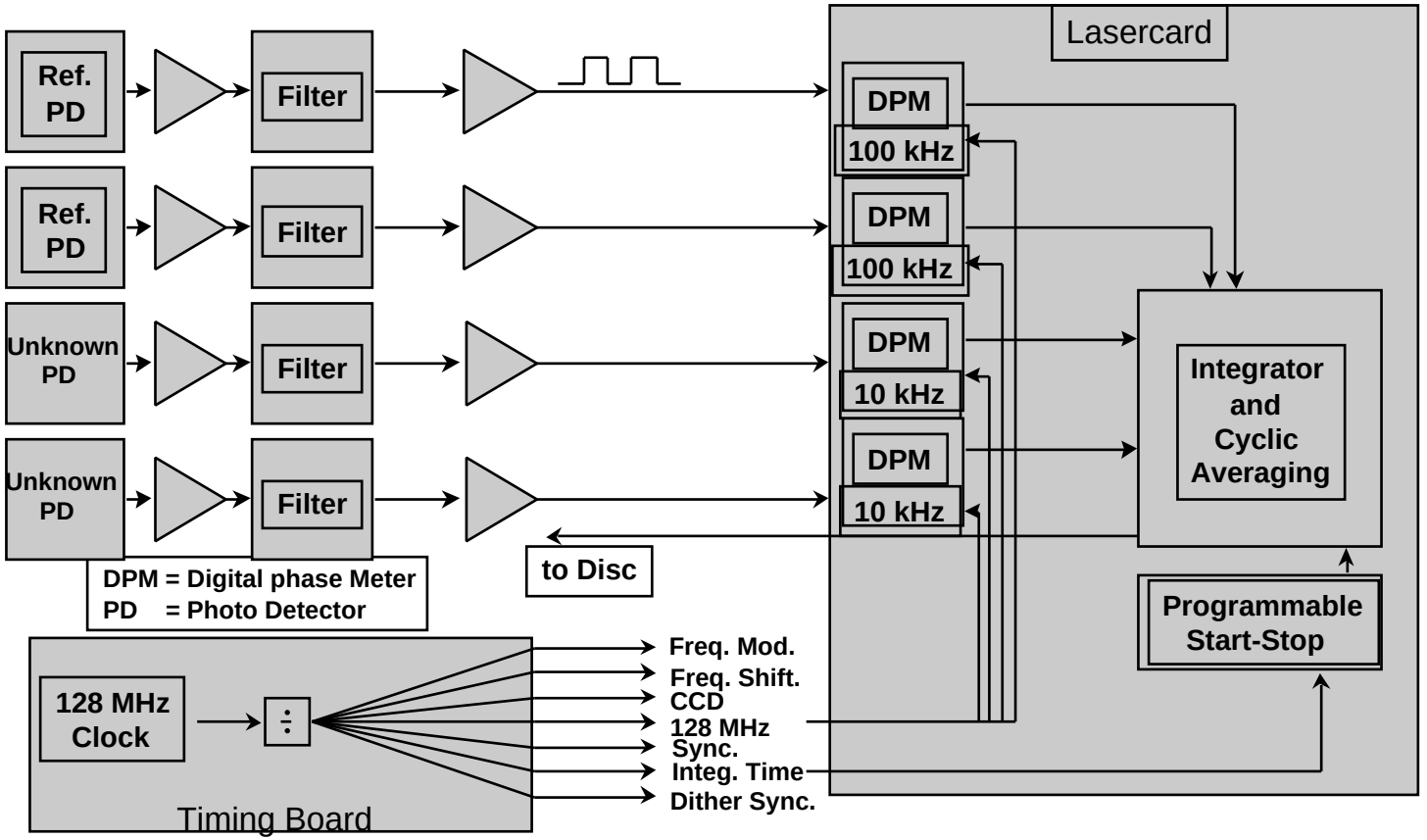
Metrology Block Diagram



Single-Metrology Channel Block Diagram



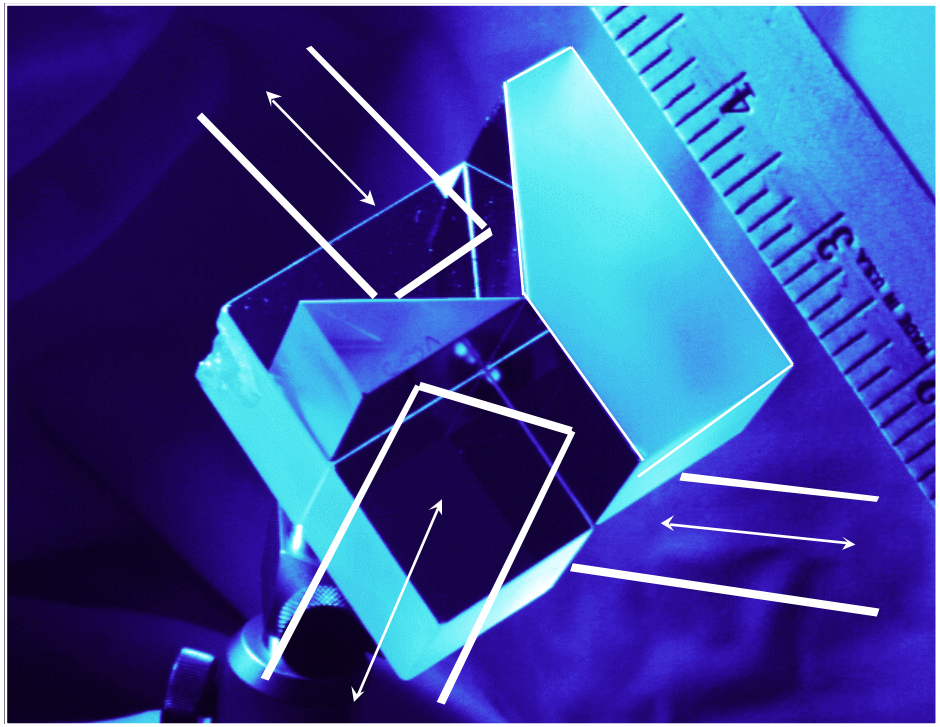
MAMTB Integrating Laser Card



SIM Fiducials

- 4-prism design, each one different
- Two fiducials, each mounted by 7 wires
  - Wires should be thin to reduce diffraction and beam walk
  - Design on large (10 cm) corner cube used 0.58 mm diameter wires ==> 0.6% aperture obscuration due to wires.
  - New design (~3 cm) can use smaller wires.

Triple Corner Cube



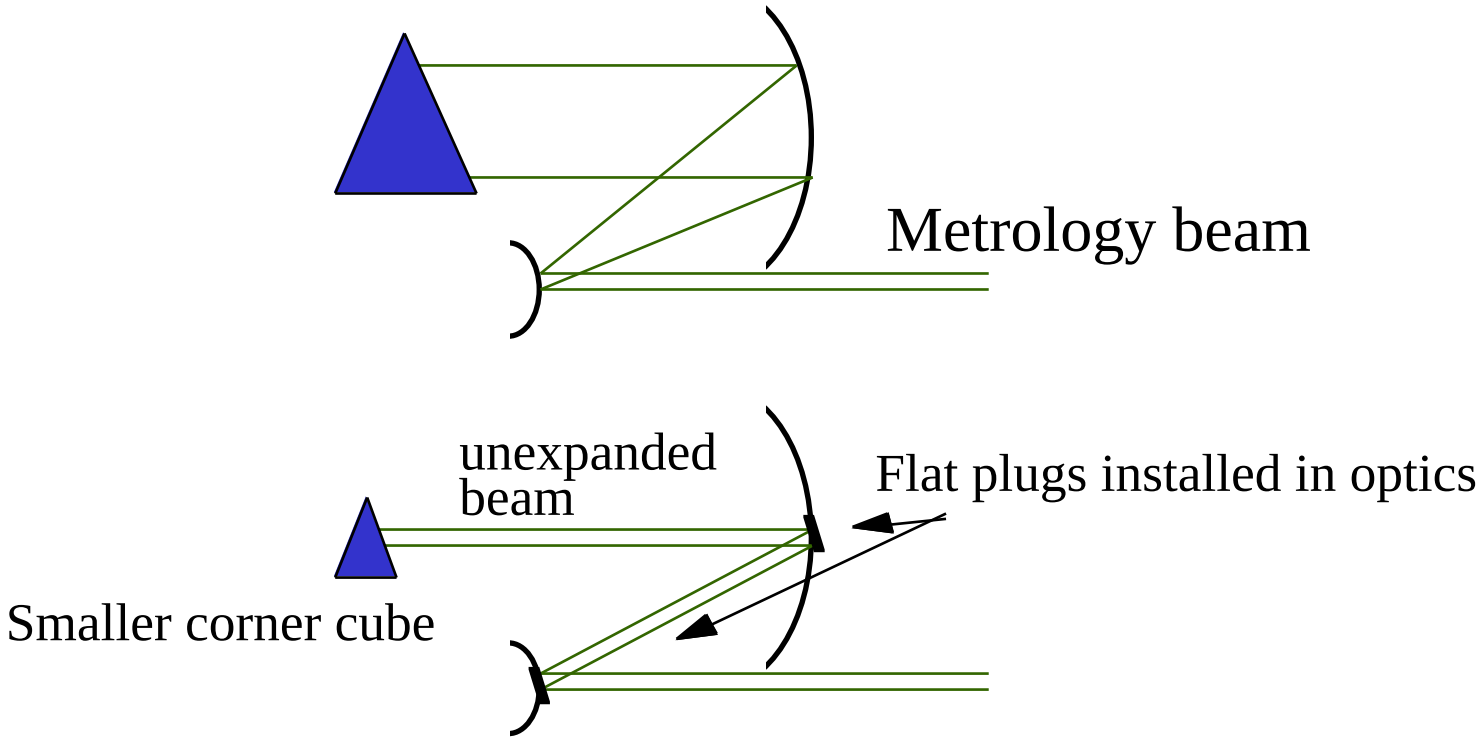
Operational Scenario

- External metrology continuously measures the distance between corner cubes.
  - Duration: one “orange peel”
  - Corner cubes are nominally static
- Internal metrology measures delay to corner cubes
  - Duration: one tile
  - Guide beams are nominally static
  - Science beam pathlength changes ~ 2 m

Impact of high-angle short baseline

- Three baselines share the same TCC face
  - They have exactly the same baseline
- The fourth baseline uses a different face
  - Non-common vertex errors (vertex-to-vertex separation) must be calibrated to ~ 1 nm
  - Become sensitive to corner-cube rotations
  - Can impact astrometric accuracy if one of the three primary baselines fails.

Front end: expand the beam?



Expand the beam?

- Expanded beam requires larger corner cube
  - maybe as large as 18 cm diameter
  - metrology beam has same magnification as starlight
- Flat plugs in optics, unexpanded beam
  - magnification difference leads to beam walk as a result of mispointing
  - plugs can potentially move

Thermal Control

- Thermal requirements on the athermalized launcher design are
  - 0.4 K stability
  - 0.4 mK gradient across 1 cm
- Both are achievable with a local thermal control system.
- Maybe MLI is adequate? Depends on what else is happening around the launchers…

Pointing of Metrology Beams

- Beams must be pointed between c.c. vertices. Pointing errors lead to OPD measurement errors.
- Studying several pointing options:
  - Dither about vertex in 5 or 6 point pattern
  - Dither in a sinusoidal pattern and demodulate
  - Quad cell in beam launcher